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COMPARATIVE STATISTICS OF RAILROAD SERVICE UNDER DIFFERENT KINDS OF CONTROL.

By C. E. Prevey.

From the standpoint of the consumer of railroad services the intrinsic merits of any railroad system are measured by the quantity and quality of the service rendered and by the price. Both quantity and quality of service and price are influenced by the character of the government control over the railroads. It is the purpose of this paper to present some of the leading facts regarding quantity and quality of service rendered by railroads under different systems of railroad control.

Among the items under the head of railroad service are the following: Frequency, speed and regularity of trains, safety, furniture, and equipment of cars; rules as to carrying baggage, conveniences of making connections, station equipment, and courtesy of officials. Only the first two of these can be studied statistically. This paper will be confined chiefly to the first item,—frequency of trains.

In comparing the efficiency of different systems of railroad control in different countries, it must be remembered that there are many other circumstances which affect the character of the service and prices besides the method of control. No decision as to the merits of government or private ownership can be drawn off-hand from a comparison of services and rates in different countries. The density of population, topography, geographical location, natural distribution of products, and, most of all, the state of civilization of the people have more to do with the development of railroading than the particular system of control adopted.

There are a number of methods of comparing railroad development which do not distinguish between quantity and quality of service: First by a comparison of the ratio of railroad mileage to area or to population. These two kinds of comparisons give widely different results and are faulty, because the former makes too favorable a showing for the small and densely populated countries, while the latter favors the large and sparsely populated countries.

Another method of comparing railroad services is the "density of traffic" measure. By this is meant the average number of passengers and tons of goods transported over each mile of railroad. The first difficulty with this comparison is that it takes no account of the extent of the railroad system. A country like India may have only a few miles of road connecting the most populous centers which will show a great density of traffic and yet the country at large be very poorly supplied with railroad facilities. In addition to the above objections to these methods of comparison there is the further objection that none of them make any account of quality of service. The patrons of the road may be accommodated by any number, more or less, of trains per annum and yet it will make no difference in the figures.

Another proposed means of comparison is by frequency of trains, which is found by dividing the whole number of miles run by trains in a year by the miles of road. This has the advantage of exhibiting the quality of service,— the more frequent the trains the greater the accommodations to the patrons of the road. It is lacking, however, in that it shows nothing about the *extent* of railroad service, or how far it meets the wants of the people as a whole.

As opposed to all these methods of comparison there is still another which does take into account to some extent the quality and quantity of service relative to the whole population. This is the train mileage per capita basis of comparison. In the denominator of the fraction, $\frac{\text{train-mileage}}{\text{population}}$ the interests of the whole people are represented. In the numerator quality and quantity are both represented in a rough way, since the mileage depends on length of road and frequency of trains. At the same time some allowance is made for density of population because the average distances will be greater in the thinly populated countries.

In Table I is shown the train mileage per 1000 inhabitants for each of the leading countries of the world for the latest dates obtainable. The countries are arranged in three groups according to the kind of control. The railroads in the first group of countries are all owned and operated by private companies with the exception of a small part of the roads in Canada.

TABLE I.—ANNUAL TRAIN MILEAGE PER 1,000 INHABITANTS.

	State.	Year.	Train Mileage per 1,000 Population.	Miles Under Control of State.	Private.
I.	United States....	1895-96	11,981	....	180,891
	Great Britain....	1895	8,815	....	21,174
	Canada..........	1895	8,134	1,346	14,631
II.	France..........	1894	4,776	1,608	22,833
	Italy.........	1890	1,237	5,260	2,895
	Switzerland.. ...	1894	4,860	....	2,220
	Hungary.........	1895	3,211	6,725	1,493
	Sweden..........	1895	1,262	1,851	3,603
	Holland..........	1894	4,040	1,936	......
	India.............	1894	227		
	"	State owns and operates..			5,198
		State railroads worked by companies....................			8,605
		Private roads..			4,697
					(*Statesman's Year Book.*)
III.	Germany	1895-96	4,328	25,205	3,032
	Belgium..	1895	5,348	2,061	794
	Russia............	1894	876	11,131	9,472
	Norway..........	1895-96	1,554	960	42
	Australia	1895-96	7,660	9,754	......

Statistics of population from the *Statesman's Year Book;* also statistics of railroad mileage in a few cases. Statistics of train mileage in this and the two following tables are from the *Archiv für Eisenbahnwesen.* Following are the citations to year and page: Great Britain, '97, 1126; Germany, '97, 1126; France, '96, 1126; Italy, '94, 894; Switzerland, '97, 84; Sweden, '97, 502; Holland, '96, 417; Belgium, '97, 1168; Russia, '97, 779; Norway, '97, 500; Hungary, '97, 945; India, '96, 779; Australia, '97, 1184; Canada, '97, 525; United States, *Poor's Manual,* '97; Austria, '97, 73.

The countries in the second group have a mixed system of government and private control. In France the government owns 1608 miles and the companies 22,833 miles, but the private roads are under a minute supervision by the government. In Italy part of the roads are owned by the state and part by private companies, but those owned by the state are leased and worked by the companies. In Switzerland the roads are owned and worked by private companies, but under the strict supervision of the government. In Sweden two-thirds of the mileage is under private control and one-third is owned by the state. In Holland the roads are chiefly owned by the state and rented out to private companies. In India both systems of railroad control exist.

In the third group of countries nearly all the railways are owned and operated by the state. In Russia about one-third* of the railroads are in the hands of companies, but the government owns a large part of the stocks.

A glance at this table shows that those countries whose roads are owned and operated by private enterprise have by far the largest train-mileage per capita. In the United States a train is run on the average 11.9 miles annually for each inhabitant. In England the number is 8.8 and in Canada 8.1 miles, while no continental European country has a train-mileage as high as five miles per capita, except Belgium, which has 5.34.

Table II shows the passenger and freight train-mileage per thousand inhabitants for the same years as given above.

The train mileage per capita is the best measure of comparative *railroad development* in different countries. That railroad development is dependent on many things besides the system of control is evident. The question arises whether there is any set of statistics of railroad services which eliminate the results of natural conditions and indicate more nearly the direct affects of the system of control.

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* The companies owned in 1894, 9472 miles, and the state 11,131 ; but at the beginning of 1896 the state owned 16,126 and the companies 8464 miles.

TABLE II.— ANNUAL TRAIN MILEAGE PER 1,000 INHABITANTS.

(Same dates as in Table I.)

	Passenger.*	Freight.
United States	4,755	7,003
Great Britain	4,733	3,843
France	2,354	1,623
Germany	2,285	1,589
Switzerland (including mixed)	3,731	1,757
Belgium	3,054	2,145

It is suggested that some approximation toward this can be made by a double comparison, *viz.*, of the density of traffic and of the frequency of trains. The reasons and the method of such a comparison are as follows: —

The efficiency of any system is measured by the quality and price of the service and the supply of services rendered relatively to the potential demand. The potential demand is measured not by the amount of the population, but by the amount of use that would be made of railroad facilities if they were offered. Now, as we have seen, the first railroads in any country connecting the principal traffic points meet a very strong demand for railroad services, and the density of traffic is very great. As the railroad is extended the demand for services "on the margin" grows less and less, and the average density of traffic diminishes. Therefore the average density of traffic is an approximate measure of how nearly the extension of railroad facilities has approached to the existing demand for railroad services. The more the railroad system is extended, other things remaining equal, the lower will be the density of traffic. The demand for

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* No account is here made of the mileage of mixed trains because complete statistics are not to be had. The proportion of mixed trains is larger in Continental Europe than in England or the United States, as shown by the following figures taken for the same dates and from the same source as the above : —

	Passenger Train Mileage.	Mixed Train Mileage.
United States	337,641,115	15,785,433
England	184,064,400	4,284,490
Germany	119,666,700	20,865,600
France	90,417,600	29,249,100

railroad services is very largely the result of natural conditions, state of civilization, etc. The supply of railroad services is very largely the result of the system of railroad control. It should be remembered, however, that the demand (as expressed in density of traffic) is very largely affected by railroad rates. Therefore, in comparing the density of traffic in different countries to determine how far the railroad system has met the demand, it is necessary to take into account the rates. Thus, in comparing the United States with India as to passenger traffic, we can not say that American railroads have necessarily come more nearly to the demands for travelling facilities on the grounds that the density of passenger traffic is greater in India. Our fares are very much higher than the fares in India, and we do not know what the density of passenger traffic would be in this country if fares were put down to the Indian tariff, nor what the density of passenger traffic in India would be if their fares were raised to the level of ours.

We can summarize the foregoing by saying that the efficiency of a railroad system in respect to quantity of service (relative to demand) is measured by the reciprocal of the average density of traffic. The quality of service is measured by the frequency of trains. These two quantities taken together are the measure of comparative service. The equation,

$$\text{Frequency of trains} + \frac{1}{\text{density of traffic}} = \text{price},$$

expresses the fact that, other things being equal, price should vary with frequency of trains and inversely with density of traffic.

Tables III and IV exhibit the density of traffic and frequency of trains of the important states. No statistics of density of traffic are kept in England, and we have not the figures for Canada, so that the only private owned roads with which we can compare are those of the United States.

TABLE III.—FREQUENCY OF TRAINS.

Average number of train-miles per mile of road.

	Total.	Passenger.*	Freight.
United States, 1896	4,702	1,867	2,750
Great Britain, 1895	16,005	8,700	7,103
Germany, 1896	8,097	4,244	2,913
France, 1893	7,608	3,756	2,580
Austria, 1895	5,219	(State roads only.)	
Hungary, 1895	5,693	....	....
Switzerland, 1894	6,451	(4,941 including mixed.)	1,510
Norway, 1896	2,905	....	....
Sweden, 1895	3,062	....	....
Russia, 1894	5,271	....	....
India, 1894	3,490	1,370	2,035
Australia, 1895-96:	....	....	....
New South Wales	3,050	1,465	1,580
Victoria	2,881	....	....
Queensland	1,993	....	....
S. Australia	2,004	791	....

TABLE IV.—DENSITY OF TRAFFIC.

Number of ton-miles or passenger-miles per mile of line. (One ton = 2,000 pounds.)

	Passenger.	Freight.
United States	72,150	519,280
Great Britain	(No statistics.)	(No statistics.)
France	261,182	350,000
Germany	315,399	616,474
Switzerland	239,403	195,503
Sweden	76,462	150,932
Russia	189,600	706,689
Norway	91,552	68,959
Belgium	498,000	(State roads only.)
Austria	217,746	414,002
Hungary	143,000	348,700
India	315,085	232,000
New South Wales	41,200	....

Comparing the United States with India as to density of traffic we find that in passenger service in the United States there are 72,150 passengers carried over each mile of road annually, while in India the number is 315,000. Ignoring the effect of the difference in rates this would indicate that in India roads have not been extended to places contributing small traffic to anything like the extent that they have in the United States. On the other hand, trains are run more frequently in the United States than in India. The number of passenger trains running over each mile of road was 1867 in the United States, and 1370 in India. Thus we conclude that, as far as passenger traffic is concerned, both the quantity and quality of service in India is far inferior that of the United States. Rates ought to be cheaper there than here, because trains run less frequently and the amount of traffic is greater, so that while in the United States the average number of passengers in a train is 35 in India it is 224 (see Table V). Comparing the United States and France, we find that for a given section of road France has over three times as many passengers to carry, and that passenger trains run about twice as often.* This shows better service in France on the lines operated. If we estimate the *extent* of service in proportion to demand by density of traffic we find that the density of passenger traffic is about three times as great in France as in the United States, while freight traffic is only three-fifths as great as in

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* See footnote, p. 137.

TABLE V.—AVERAGE TRAIN LOADS.

	Passenger-Miles Per Passenger Train Mile.*	Ton-Miles Per Freight Train Mile.
United States	35	180
Germany	72	190
France	69	130
Switzerland	48	(Mixed train mileage included.)
Belgium	66	....
India	224	142
New South Wales	26	....

* See footnote, p. 137.

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* No account is made of mixed trains. In France the mileage of mixed trains is one-third of that of passenger trains, while in the United States it is about one-twenty-second.

the United States. This disparity between the density of freight traffic and passenger traffic makes it difficult to give the United States any definite rank from the stand-point of intensity of traffic. The passenger traffic of the United States is less dense than that of any European country, while the freight traffic is more dense than that of any country except Germany and Russia.

While this method of comparing quality of service will not enable us to establish definitely the relative quality of railway service in different countries it helps to correct some wrong impressions which result from a comparison of train-mileage per capita. Thus it is said that railroad fares are higher in this country than in Europe, partly because trains run oftener here than in Europe and carry smaller loads, whereas the statistics show that our passenger trains run less frequently than those of Europe. In the United States the annual number of passenger-train miles per mile of road is 1867; in England, 8700; in France, 3756; Switzerland, 4941; Germany, 4244; Belgium, 7215. It can not be maintained, therefore, that our train service is better than the European, unless it be on the grounds that European railroad systems are not so extensive as ours, — that they do not supply railroad facilities to so large a part of the population in remote districts where traffic would be small.

How far this is true is partly indicated, we think, by the table of density of traffic. All the European countries, except Germany and Russia, have a lighter freight traffic than the United States, which would indicate that their railroad systems were more extended in proportion to demand than ours. On the other hand, all the countries of Europe have a heavier passenger traffic than the United States. That the latter fact is due in large part to the lower fares in Europe is shown by the fact that in Hungary, when the zone tariff system was established a few years ago with a reduction in fares of from 40 per cent to 50 per cent, the number of passengers carried trebled the first year.* Even before the reduction in rates their fares were much lower than ours. It seems probable that if fares in Europe were as high as in America the density of traffic would not be much greater.

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* *Review of Reviews*, vol. v, p. 562.

In order to compare the train service of European railroads with that of roads under private ownership having equal density of traffic we have constructed Table VI. In this the states of the Union are divided into eight groups, and the table shows for each group of states the density of population, the density of passenger traffic, the per capita train-mileage, the number of miles run by passenger and freight trains per mile of road (frequency of trains), and the average train loads.

TABLE VI.—RAILROAD TRAFFIC IN THE UNITED STATES.

Group.	Passenger and Freight-Train Mileage per 1,000 Population.	Passenger-Train Mileage per Mile of Road.	Freight-Train Mileage per Mile of Road.	Passenger and Freight-Train Mileage per Mile of Road.	Passenger-Mileage per Mile (in 1,000).	Ton-Mileage per Mile.	Passenger-Train Load.	Freight-Train Load.
1	10,410	4,113	3,150	7,263	253 —	476 —	61	151
2.........	15,044	4,100	6,690	10,790	170 —	1,410 —	41	210
3.........	16,100	1,880	2,880	4,760	64.4	545	34	188
4.........	7,180	1,220	1,700	2,920	39	330	32	193
5...... .	4,497	1,480	2,240	3,720	49.6	391	33	175
6.........	8,911	1,150	1,770	2,920	34	263	29	138
7	9,320	920	1,550	2,470	29.5	323	32	207
8.........	9,740	1,130	1,430	2,560	62.1	269	55	187
Mass.....	17,520	11,387	8,000	19,387	769.0	1,036	63	129

States in Each Group.	Density of Population.
1. Maine, N. H., Vt., Mass., R. I., Conn.,	80
2. N. Y., N. J., Penn., Del., Md.,	137
3. Ohio, Mich., Ind., Ill., Wis.,	65
4. Va., W. Va., N. C., S. C., Ga., Fla.,	78
5. Ala., Miss., Tenn., Kentucky, La.,	44
6. Mo., Ark., Texas, Kansas, Col., N. Mexico, Okla.,	14
7. Iowa, Minn., Neb., N. Dakota, S. Dakota, Wyoming, Montana,	9
8. Wash., Oregon, Cal., Nevada, Arizona, Idaho, Utah,	4
Massachusetts,	315

Railroad statistics from *Poor's Manual*, 1897. Population from *World Almanac*, 1897, p. 515.

We get, now, some very interesting results by comparing the different countries of Europe with that portion of the United States which most nearly resembles it in density of population and density of railroad traffic. Thus we will compare New England with Germany, France, Austria, and Switzerland: —

	Area.	Density of Population.	Density of Passenger Traffic.	Density of Freight Traffic.	Passenger-Train Mileage Per Mile.	Average Passenger Load.
New England	33,040	80	253	476	4113	61
Germany	211,103	201	315	616	4244	72
France	204,177	182	261	350	3756	69
Austria (state roads)	....	..	217	414	(5219 total)	..
Switzerland	15,981	181	239	195	(4941 including mixed)	48

(The figures under the heading "Density of Passenger Traffic" represent the number of thousands of passenger miles per mile of road. The figures in the next column show the number of thousands of ton-miles per mile of road.)

In Germany the density of passenger traffic is only one-fourth greater than in New England, and the freight traffic is 29 per cent greater. The frequency of passenger trains is a little greater in Germany than in New England. In France the density of passenger traffic is greater than in New England, the freight traffic is 64 per cent as great, and the frequency of passenger trains 92 per cent as great. So far we have not taken into account the mixed trains, because the mileage of mixed trains is not given for the separate states of the Union, nor for all the European countries. We find, however, that for the United States the mixed-train mileage is only about one-twenty-second of the passenger-train mileage, while in France it is one-third, and in Germany one-sixth of the passenger-train mileage. After making proper allowance for mixed trains we would find that the frequency of trains carrying passengers is greater in Germany and France than in New England.

In Austria the number of passenger-train miles is not given separately, but we may estimate them to be about three-fourths as many as in New England, and considering that the traffic is considerably lighter we see that even Austria is much better supplied with railroad facilities than is commonly supposed. Switzerland we find with a considerably lighter traffic, has a considerably larger number of passenger and mixed trains, and a much smaller average load.

Again, let us compare Hungary with the north middle states: —

	Density of Population.	Density of Passenger Traffic.	Density of Freight Traffic.	Passenger-Train Mileage Per Mile.
States....................	137	170	1410	4100
Hungary....................	137	143	348	(3000, estimated)

(The total train mileage per mile in Hungary is 5693, and we estimate the passenger mileage at about 3000 miles.)

In round numbers, Hungary, with a passenger traffic seven-eighths as dense, and a freight traffic one-fourth as dense, has about three-fourths as many passenger trains per mile per annum as has the great trunk line region of this country.

For a comparison of regions with lighter traffic we take Norway and Sweden and compare them with the United States west of the Rocky Mountains (Washington, Oregon, California, Nevada, Arizona, Idaho, and Utah): —

	Density of Population.	Density of Passenger Traffic.	Density of Freight Traffic.	Passenger-Train Mileage Per Mile.
States....................	4	62	269	1130
Norway....................	14	91	68	(total, 2890)
Sweden....................	27	76	150	(total, 3062)

Norway and Sweden have a heavier passenger traffic than the western states, but their passenger trains run oftener also. The total number of train miles per mile of road per annum is 2890 in Norway and 3062 in Sweden, and the number of passenger-train miles probably more than half of these figures, as compared with 1130 in the western states.

New South Wales has a density of passenger traffic of 41,200, — a little less than that of the southern states: Alabama, Louisiana, Mississippi, Tennessee, Kentucky, and passenger trains run with about the same frequency, the passenger-train mileage per mile being 1465 in New South Wales, and 1480 in the southern states.

If these comparisons are worth anything they show that European railroads, being chiefly under government ownership and charging much lower passenger rates, have supplied the demands for railroad facilities about as well as have the railroads of the United States. In frequency of trains they are seldom behind and usually ahead of American railways. High fares in the United States cannot be justified on the score of frequency of trains or size of train loads.